Meigs (A. V.)

THE

ARTIFICIAL FEEDING

OF INFANTS.

BY

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Presented by the author

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In addressing a society the special purpose of whose existence is the study of the diseases of children, no excuse is necessary for having chosen as a subject the artificial feeding of infants. That preventive medicine can accomplish more for the general good than any other branch of our science is a fact which receives almost universal acceptance, and it must be acknowledged that so long as there continues to be any great disagreement among physicians with regard to how infants should be fed, of the various methods chosen, most must be bad, and from their pursuance must result the foundation in the earlier months of life of much disease. It is this diversity of opinion among those who are looked up to as authorities in the community that is most to be deplored, and it is a very hopeful thing to be able to believe, as for my own part I do, that this diversity not only will be, but actually is now being removed, owing to the efforts of scientific men to come to a common understanding of the matter. In endeavoring to reach a conclusion there are, as I have already pointed out in previous publications,* but two possible methods, the one purely empyric, to experiment with various foods until the best is found; and the other, by analysis, or otherwise to learn as nearly as possible what human milk is, which we all know to be the most perfect food for infants, and then to make an imitation of it. It is a most fortunate thing that all knowledge of the subject at the present time, both that derived from the first as well as the second method of investigation, seems to lead towards a common conclusion.

* "Milk Analysis and Infant-Feeding," by Arthur V. Meigs, Phila., 1885.

It may be assumed that in civilized countries, at the present time, cow's milk forms the basis of all the different foods which are used for infants, for though there are here and there occasionally persons who recommend foods which contain no cow's milk, or even no milk of any kind, yet they are so few that they need not be taken into account. It has been said that both clinical investigation and analysis have of more recent years been leading towards an identical conclusion, and of this any one may be convinced who will turn to the more modern literature. For a long time most students of the subject have advised that, before administering cow's milk to young infants, it should be diluted, and more and more it will be found, as we come down towards the present time, that writers speak of the great advantages to be derived from the use of cream, and at the same time say that sugar should be added to the food. Such have been the results of the labors of practising physicians who have based their conclusions solely upon the effects they have derived from the use of different foods, recommending finally that with which they best attain their end,—the successful rearing of infants by hand. This is what has been learned from clinical investigation of the subject or, as it may be called, the practical study. Now, what have been the results of an approach to the subject from the theoretical stand-point,—of chemical analysis of various foods, and of cow's and human milk in particular? So far as I have been able to learn, there has at no time been any disagreement among chemists in regard to the composition of cow's milk, results which for all practical purposes may be called identical, having been reached by all. When different analyses of human milk, on the other hand, are compared, it is seen that widely-diverging results have been reached. The differences have been in regard to the amounts of casein and sugar present, the estimates of various chemists of the other constituents having been alike. It is strange to notice, and very significant, that however widely the estimates of these two substances (casein and sugar) may differ, the sum of the amounts, if added together, is in every instance almost the same. This is not the time to draw up the figures in array and compare them, especially as I have already fully (loc. cit.)

done so elsewhere, but it is remarkable that no one earlier suggested that the great variability presented by different specimens of human milk had no real existence, but was due to faulty methods of analysis. The mean analysis of Vernois and Becquerel has been and continues to be more widely quoted than any other single analysis, and yet their estimates of the various constituents are so nearly identical with the amounts of the different component parts contained in cow's milk that it might well be taken as an average analysis of good ordinary cow's milk.

At the same time that authors quote with approval the analysis of human milk of Vernois and Becquerel, they will state that human milk contains much less casein and more sugar than does cow's milk, never taking into account that the figures quoted directly contradict their statements, and failing to see that the explanation lies in the fact that the analysis is incorrect. More modern chemists, as a general thing, tend to estimate the casein at a less amount; and this is perhaps typified by the statement of Biedert that he accepts as correct the estimate of Vierordt of the casein of human milk at two per cent., but at the same time says that in the artificial feeding of infants not more than one per cent. of the casein of cow's milk must be introduced, because he finds that infants cannot digest it, and this he attributes to the greater degree of indigestibility of the casein of cow's than of human milk. Wanklyn, in his book upon "Milk Analysis," strikes at the root of the subject when he says that within limits milk presents great constancy of composition, and that in this constancy of composition lies the whole basis of the value of milk analysis.

It is now more than seven years since I made the statement* that human milk never contains more than about one per cent. of casein, and that all the analyses, both the older and more modern ones, which estimated its amount as high as three or four per cent., were incorrect—from this statement I have never seen the slightest reason to recede. If this estimate

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* "Milk Analysis," by Arthur V. Meigs, *Philadelphia Medical Times*, July 1, 1882.

ever comes to receive general acceptance among scientific men, owing to its truth having been so fully proved that no one can any longer deny it, a long step will have been made towards improvement in our methods for the artificial feeding of infants, for then, as there will be a good and plain reason why it should not be done, no one will dare to feed young infants upon pure cow's milk which contains three per cent. or more casein. One of the latest utterances upon this subject is to be found in the article upon "Infant-Feeding—Weaning," by T. M. Rotch, M.D., in the "Cyclopædia of the Diseases of Children," vol. i., edited by Keating. In an admirable essay, far in advance in its teachings of anything else upon the subject with which I am familiar, and embodying the results of much study, both from the theoretical and practical sides of the question, the author gives as a standard of the ordinary composition of human milk estimates of the various constituents almost identical with my mean analysis. In another part of the article he gives analyses in which he places the amount of casein as high as two and even four per cent. To me it seems impossible that we can ever place the subject upon a stable basis until it is either proved or disproved whether human milk can ever contain so much casein. From a considerable personal experience in the analysis both of cow's and human milk, I still hold firmly to my statement made years ago, in agreement with Wanklyn, that it is upon the quite near constancy of composition presented by milk that depends the value of its analysis to science. It is to be deplored, therefore, that Rotch did not mention the method by which his analyses were made, and give also the source from which he derived that which he accepts as a standard of the ordinary composition of human milk, for to any one of my way of thinking it is impossible to believe that both his analyses and his accepted standard can be correct.

Since the issue of my first publication upon this subject, I have never had reason to change any of the broader generalities upon which were based the advice in regard to feeding then given. The recommendations were the result of careful study of the subject from both the practical and the theoretical aspects, clinical experience having led me to select a food

very nearly like that which I have since arranged; and then analysis having brought me, quite contrary to what my preconceived ideas had led me to expect, to a similar result. It is this agreement of the results obtained both from the practical and theoretical investigations that makes the case an especially strong one; clinical study having led to a conclusion, and then theory stepping in to confirm it and make plain the reason. Experience taught physicians that infants could not digest pure cow's milk which contains three to four per cent. of casein, and chemical analysis gives the explanation—human milk never contains more than about one per cent.

In medicine almost always more weight should be given to the teachings of experience than to the apparent indications of pure science and theory, and yet it has often happened that that which we have learned from practice and clinical study has been confirmed and explained by pure science. Where the two methods led to conclusions apparently contradictory, I should always prefer to abide, provisionally at any rate, by the results of practice. Though, as has been stated, I have seen no reason to make any radical change in my artificial food, which was based upon the dilution of cow's milk, for the reason that it contains too much casein; the further need for the addition of cream, because in diluting the fat was reduced to too small an amount; to the addition of sugar to make it equal to the amount contained in human milk; and of lime-water to change it from being an acid to an alkaline fluid; I have fallen upon several improvements to render it easier to get together the required amounts of the different constituents and thus simplify the work of the nurses; besides which, I have had a good deal of experience in the actual use of the food, and therefore opportunity to observe its clinical effects. It is only in the directions indicated that I have anything which is absolutely new to detail, but perhaps some account of them may not be without interest to the members of the Society.

In the mode of preparation of the food, I have made one change which, though it in the end arranges the constituent parts in exactly the same proportions, is an improvement in that it simplifies the preparation and offers less chance for

fermentation to take place. Cream is a material which, as it is ordinarily obtained in cities, and even if people have their own cow, has been kept so long that it is very liable to become sour. I therefore now direct—and this was alluded to in an article I published some time ago *—that instead of taking cream and milk in the proportions respectively of two and one in eight, three parts of a weak cream be used, which is obtained as follows: One quart of good ordinary milk is placed in a high pitcher, or other vessel, and allowed to stand in a cool place for three hours; then one pint is slowly poured off from this, care being taken that the vessel is not agitated, the object being to obtain the upper layer of fluid, rich in fat, and leave the lower, comparatively poor portion behind. When the child is to be fed, there are taken of this weak cream three tablespoonfuls, of lime-water two tablespoonfuls, and of sugar-water three tablespoonfuls. The sugar-water is to be made in the proportion of eighteen drachms of milk-sugar to one pint of water. This makes only four ounces of food, and if the infant is old enough to require eight ounces at once, double the quantities of each of the ingredients must be mixed. This is simply warmed in a bottle, as usual, and is then ready for use. Analyses of mixtures made according to these directions have shown me that the proportion of fat is the same as when the food is prepared as recommended in my earlier works, and the plan is much better, because more economical (cream being expensive), and the food is less likely to ferment. In the article by Rotch, which has already been quoted, he suggests that it is of advantage to use the sugar in powder instead of dissolving eighteen drachms of milk-sugar in a pint, and recommends the use of three and three-eighths drachms of sugar to eight ounces of food, to be made exactly as directed above, except that the sugar-water is then substituted by an equal amount of plain water. To obtain the desired amount (three and three-eighths drachms) of sugar, he has had constructed a little measure which will hold just that quantity. Doubtless this suggestion is a good one, and in

* A paper read before the Pediatric Section of the New York Academy of Medicine upon the "Dietetic Management of the Summer Diarrhœa of Infants," *Medical News*, July 7, 1888.

many instances it will be of advantage to follow it. He also criticises my food on account of the amount of lime-water it contains, and says that it is much more strongly alkaline than human milk. This statement he supports by saying that he has had the degrees of alkalinity of the two fluids, human milk and an artificial food, made as I have directed, tested, with the result above stated. As he does not mention the method used in making the test, though it was presumably by neutralizing certain quantities of an acid of a standard strength, and as clinical experience, which I have already said I think should be given much more weight than theoretical reasoning when unsupported by practice, has given me most admirable results, much better than with any other food, I am disposed still to think the mixture a good one. The criticism of Rotch is however a just one, and quite admissible, and it will be for the future to determine which is the better proportion of lime-water, the amount I have recommended or that he suggests (one-sixteenth of the total volume).

During seven years I have had a good deal of experience in the use of the food in private practice, and in the last two in an institution where there are always quite a number of foundlings. From both methods of trial the results have been better than my most sanguine hopes had led me to expect. In private practice, if I have had intelligent people to deal with, and could gain their confidence so that they would do exactly as I directed, the result has almost uniformly been success; on the other hand, if people are foolish, and try a succession of different foods, or are impatient, so that they will not hold to the plan long enough to give it a fair trial, failure often attends one's most strenuous efforts. The greatest difficulty that I have to contend with in the effort to artificially feed any infant successfully is this natural impatience on the part of parents, which expresses itself in the desire to be constantly trying different foods in such rapid succession that no one of them is given an adequate trial. The task of the physician therefore is, and an infinitely difficult one it often proves to be, to decide in his own mind definitely what food will be most suitable for any given case, and then with all his might, until there arises some real and definite reason to think he is

in error, to hold to it in despite of the opposition of parents, nurses, relations, and friends. His worst enemies will often prove to be the nurses, especially if they be old, for the knowledge necessary to make up the education requisite for nursing is just enough to make them often think they know much more than they do. How often I have been brought almost to desperation by finding that an old nurse was defeating all my best-laid plans, and in such a way that I was entirely powerless to effect anything!

The results of the use of the mixture during my terms of service in the past two years in an institution have been most curious. There can be no test of an artificial food so severe and none therefore so good as to feed infants with it from the very hour of their birth, and it has always been my desire to test my mixture, if the opportunity ever arose, in this manner. When I began its use in an institution (the Sheltering Arms of Philadelphia), I was careful to direct its administration only to very young infants, upon their first coming under our care, and to those who after a fair trial of whatever they might previously have been taking evidently did not thrive, so that a change became necessary. No radical change, therefore, was made in the manner of feeding infants already inmates of the institution. The general results attained at the end of my first term of service were most discouraging, all the infants brought in during the first few weeks of life died, and many of the older ones, and the worst was that a goodly number of them died of infantile atrophy. When I looked back and contemplated the result of my efforts,—total failure,—I was at times disposed to be in despair, and to give up the struggle which had been in many ways a very hard one, and in the course of which I had had many obstacles to contend with, some of which had been overcome while others had for the time proved insuperable. Two things, however, would return to my mind whenever I thought of the subject, and their contemplation gave me courage to renew my efforts,—they were that in private practice I had had such uniformly good results from the use of the same food, and that the class and condition of the infants was such as necessarily to render their rearing a most difficult task, for most of them were brought

to us in a very bad state of nutrition, and were, in many instances, foundlings that had been already half starved or exposed. Reflection upon these considerations could but lead to one of two conclusions: either the infants were, without a single exception, so unhealthy that they had not sufficient vital force to live upon a food that did perfectly well in almost all instances in private practice, or else my directions had not been thoroughly carried out. Soon the further conclusion forced itself upon me that the latter must have had a large influence in causing my failure, for among my subordinates, who were to carry out my plans, not one—nurses, attendants, or any one else—had the slightest faith in my method, and though in some instances I was sure they conscientiously did their duty, yet it was only in a half-hearted way, for they had no faith, and looked forward only to failure; in others, I had reason to know that the food was not given as directed. When the time came to enter upon a second term of service the aspect of affairs had undergone a great change, all those who were to work subject to my direction had been long enough in the institution to have become pretty well discouraged at finding their own efforts almost entirely futile, as a very large proportion of the infants still continued to waste and die. The only notion that seemed very prevalent and to have much strength was a belief that Mellin's food was a very excellent thing. As I had already formed a favorable opinion of this food myself, I determined to turn the desire to use it (that evidently existed) in the direction of gaining my own ends. This I did by directing that the infants, all those young enough, should be fed upon my mixture with the addition of a teaspoonful of Mellin's food to each eight ounces, and by this means began my work with a satisfied and even enthusiastic set of assistants. It was soon found necessary to do something to make it easier to obtain the needed weak cream than setting it in pitchers, and this was easily accomplished by having a high tin cylindrical vessel made about six inches across and perhaps a foot or eighteen inches in height, which would hold exactly six quarts. In the side of this vessel, just half-way between top and bottom was a small hole which was stopped with a cork; this simple arrangement being used rather than a stop-

cock, because so much more easily kept clean. This vessel was filled with milk, and, after being allowed to stand for three hours in a cool place, the cork was removed and the upper half of the milk ran into a vessel placed to receive it, giving three quarts of cream of the desired strength. The results obtained from the use of the food during last winter were simply marvellous, one or two infants that were so wasted when the change was instituted that it seemed that they must surely die recovered, becoming well nourished and healthy, and throughout the whole season we only lost one baby of true infantile atrophy. It seems to me that it would be very absurd to suppose that the good results attained were in any material way brought about by the addition of Mellin's food, which I used merely to please my assistants, for I have as a rule had just as much success in private practice when it has not been used.

Most of these infants throve and seemed to be well until they were nine months or even a year old; but during the past summer many of them have died. The most common mode of death was for them to be seized with convulsions while in apparently good health, except that they were teething, and to die in from a few hours to a day or two. Notwithstanding these great discouragements, it really seems as if a step in advance had been made, for, so far as my own experience is concerned, I have succeeded in preventing the immediate commencement of wasting in foundlings upon their admission to an institution. The question remains an open one, whether they died during the teething process, as they did, because the diet was faulty, or if it was on account of bad regimen. For my own part, I am more than half inclined to think the latter, for in private practice and in the institution I have used exactly the same food, but how different has been the care and management of the infants, and how different the results! It is to be hoped that further study and more time will enable us to overcome the difficulty, whatever it may be, though it should be remembered that the material dealt with (foundlings already injured by exposure and neglect, and a large proportion having within them the seeds of hereditary disease) must always be the most difficult possible to manage.

There can be no doubt, I think, that of late years we have made very great strides in advancing our knowledge of the proper *rationale* of infant-feeding, and have had correspondingly increased success in coping with the practical difficulties to be overcome, as evidenced by the much larger number of infants that are successfully brought up by hand. It is unfortunate, however, that the knowledge which makes it possible to do this is still confined to a comparatively small part of the profession, the majority of physicians not interesting themselves sufficiently in the subject to take the trouble to learn the principles upon which an understanding of the method is based. It is to be hoped that the time is not far distant when it will be as fully acknowledged and as universally known that to artificially-fed infants the best method is to take cow's milk and dilute it, and use cream, sugar, and lime-water, as it is now a common dictum that the diet in typhoid fever must be liquid.

Improved modern methods of feeding, and the greater degree of success attained thereby, have made it proper to look upon the question of employing wet-nurses from a somewhat different stand-point from formerly. The results of artificial feeding used to be so bad that in all cases, if it was in any way possible, it was wrong not to obtain a wet-nurse. Now we may give much more weight to a consideration of the many risks run from the woman's being perhaps diseased or having an insufficient supply or bad quality of milk, and that they are so apt, in this country at least, to become discontented, and go away without previous notice, just at some critical period of the infant's life. The class of society from which wet-nurses are drawn is a very low one, for they are, as a general thing, either women from the lowest ranks of life, who have had illegitimate children or have been deserted by their husbands, and therefore the chance of their being diseased is very great; and, besides, they are generally of such a low order as to be difficult to manage. Upon the other hand must be set the facts, that in artificial feeding, if the food is impure or the various component parts are not present in the right proportions, the fault is ours, and the remedy is easily applied. If we have intelligent people to deal with,

and have their full confidence, so that they will carry out implicitly the directions given them, infants may be hand-fed with great success, and in some instances with more success than from the employment of wet-nurses, though, of course, there is not now and probably never will be, found any artificial food which will be equal to that provided by nature when it can be had at its best.

The end to be striven for in order that more general success may be attained in the artificial feeding of infants is to diffuse more widely and to make common property of the knowledge how small a proportion of casine exists in human as compared with cow's milk, and that in addition to the dilution which is necessary to reduce the amount of this constituent we must use in proper proportions,—cream, sugar, and lime-water.